DOCUMENT RESUME

ED 147 464 CE 012 460

TITLE Energy and Power Technology. Curriculum Guide.
INSTITUTION North Dakota State Board for Vocational Education, Bismarck.
PUB DATE [77]
NOTE 102p.; For related documents see CE 012 456-460
AVAILABLE FROM Industrial Technology Department, University of North Dakota, Grand Forks, North Dakota 58202 ($4.00; set $15.00)

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Career Exploration; Curriculum Guides; Educational Objectives; *Energy; *Industrial Arts; Industrial Education; Junior High Schools; *Learning Activities; Middle Schools; *Power Mechanics; State Curriculum Guides; Teaching Guides; Technology

ABSTRACT

One of a set of six guides for an industrial arts curriculum at the junior high school level, this guide provides the basic foundation to develop a one-semester course based on the cluster concept, energy and power technology. The guide suggests manipulative and experimental student-conducted activities or teacher demonstrations which focus on the socioeconomic and environmental impact of energy usage and the safety, efficiency, and occupational aspects inherent in the energy/power (E/P) field. Following an introduction covering rationale, cluster outline and objectives, and cluster taxonomic structure, seven units are presented: introductory concepts, safety concepts, energy forms and sources, energy harnessing systems and Newton's Laws, E/P transmission and control, E/P utilization, and E/P career opportunities. Each unit includes unit objectives, student competencies and related student activities, unit outline, and where applicable, illustrations and information sheets. (SH)

****
* Documents acquired by ERIC include many informal unpublished *
* materials not available from other sources. ERIC makes every effort *
* to obtain the best copy available. Nevertheless, items of marginal *
* reproducibility are often encountered and this affects the quality *
* of the microfiche and hardcopy reproductions ERIC makes available *
* via the ERIC Document Reproduction Service (EDRS). EDRS is not *
* responsible for the quality of the original document. Reproductions *
* supplied by EDRS are the best that can be made from the original. *
****

ED147464

INDUSTRIAL ARTS

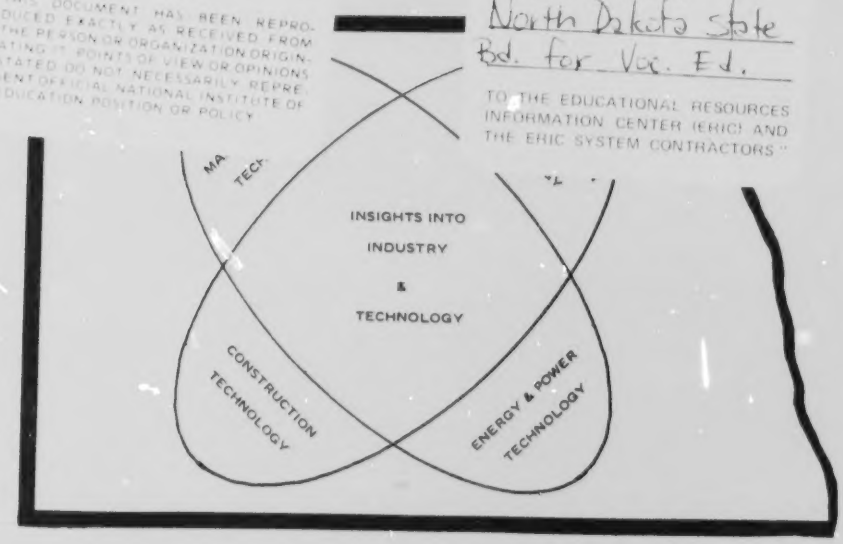
ENERGY and POWER TECHNOLOGY

Curriculum Guide

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY.

"PERMISSION TO REPRODUCE THIS MATERIAL BY MICROFICHE ONLY HAS BEEN GRANTED BY
North Dakota State Bd. for Voc. Ed.
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND THE ERIC SYSTEM CONTRACTORS."



NORTH DAKOTA

NORTH DAKOTA STATE BOARD FOR
VOCATIONAL EDUCATION
Bismarck, North Dakota

OE 012 400

TABLE OF CONTENTS

ENERGY/POWER TECHNOLOGY

RATIONALE 1
OBJECTIVES 2
GUIDELINES FOR IMPLEMENTATION 3
TAXONOMETRIC STRUCTURE 5
BODY OF KNOWLEDGE 6
LIST OF MAJOR UNITS 15

COURSE CONTENT

UNIT I	ENERGY/POWER INTRODUCTORY CONCEPTS	1.1
UNIT II	ENERGY/POWER SAFETY CONCEPTS	2.1
UNIT III	ENERGY FORMS AND SOURCES	3.1
UNIT IV	ENERGY HARNESSING SYSTEMS AND NEWTON'S LAWS	4.1
UNIT V	ENERGY/POWER TRANSMISSION AND CONTROL	5.1
UNIT VI	ENERGY/POWER UTILIZATION	6.1
UNIT VII	ENERGY/POWER CAREER OPPORTUNITIES	7.1

APPENDICES

BIBLIOGRAPHY . . . . . A
VISUAL AIDS SOURCES . . . . . B
SAMPLE STUDENT ACTIVITY REPORT FORM C

ENERGY/POWER TECHNOLOGY

RATIONALE: The purpose of studies in the energy/power cluster area is to develop a realization, through activity-oriented instruction, that the six forms of energy; their availability, conversion, efficient usage, and future development are essential to man's existance. Studies within this cluster area are complimented with both manipulative and experimental student-conducted activities, or teacher demonstrations, which emphasize the technical phenomenon involved. These studies impress upon the student the socioeconomic and environmental impact of energy usage and the safety, efficiency, and occupational aspects inherent in the energy/power field.

The seven major units of the study cluster effectively cover most energy/power concepts at the middle school level. Four of the seven major units follow a pattern of identifying subconcepts in accord with the six forms of energy (chemical, electrical, light, mechanical, nuclear, and thermal) which are initially encountered in unit three. Thus, a broad coverage of energy/power, including "alternative sources for the future," is made possible without specifying any paticular form as more applicable to the past, present, or future. The separation of "sources" from "forms" in the third unit is significant because, though most of the "forms" have been used extensively throughout man's history, no form is presently scarce. Some "sources" of several "forms" are becoming more scarce, thereby necessitating extensive research regarding future sources.

OBJECTIVES: The general objectives of the energy/power technology cluster are:

1. To develop an insight and understanding of the broad energy/power field and its importance to our society.
2. To discover and develop attitudes, interests, and individual potentials related to the energy/power industry through problem solving using tools and products of industry.
3. To develop career awareness through pre-vocational experiences and information relating to the world of energy and power.
4. To facilitate wise utilization of energy and power as a consumer.
5. To develop abilities for the safe and proper use of energy and associated substances, materials, and/or devices.

ENERGY/POWER TECHNOLOGY

GUIDELINES FOR IMPLEMENTATION

Energy/power as a field of study has been made more necessary by the recent realization that our modern world has developed itself into an energy starved situation. This realization, plus a need for a cohesive teachable body of knowledge in the field is the impetus behind the development of this cluster approach guide.

The Body of Knowledge is so vast a field has necessarily been de-limited to, what the committee believes, is a teachable whole; this is reflected in the outline of the Body of Knowledge. The imaginative teacher can readily expand and/or modify this curricula to improve classroom instruction.

The activities which the instructor chooses from this guide are not intended to be used exclusively as demonstrations, group, or individual student projects. They are intended to be suggestive of what types of activities should be used in all three to reinforce text and lecture material.

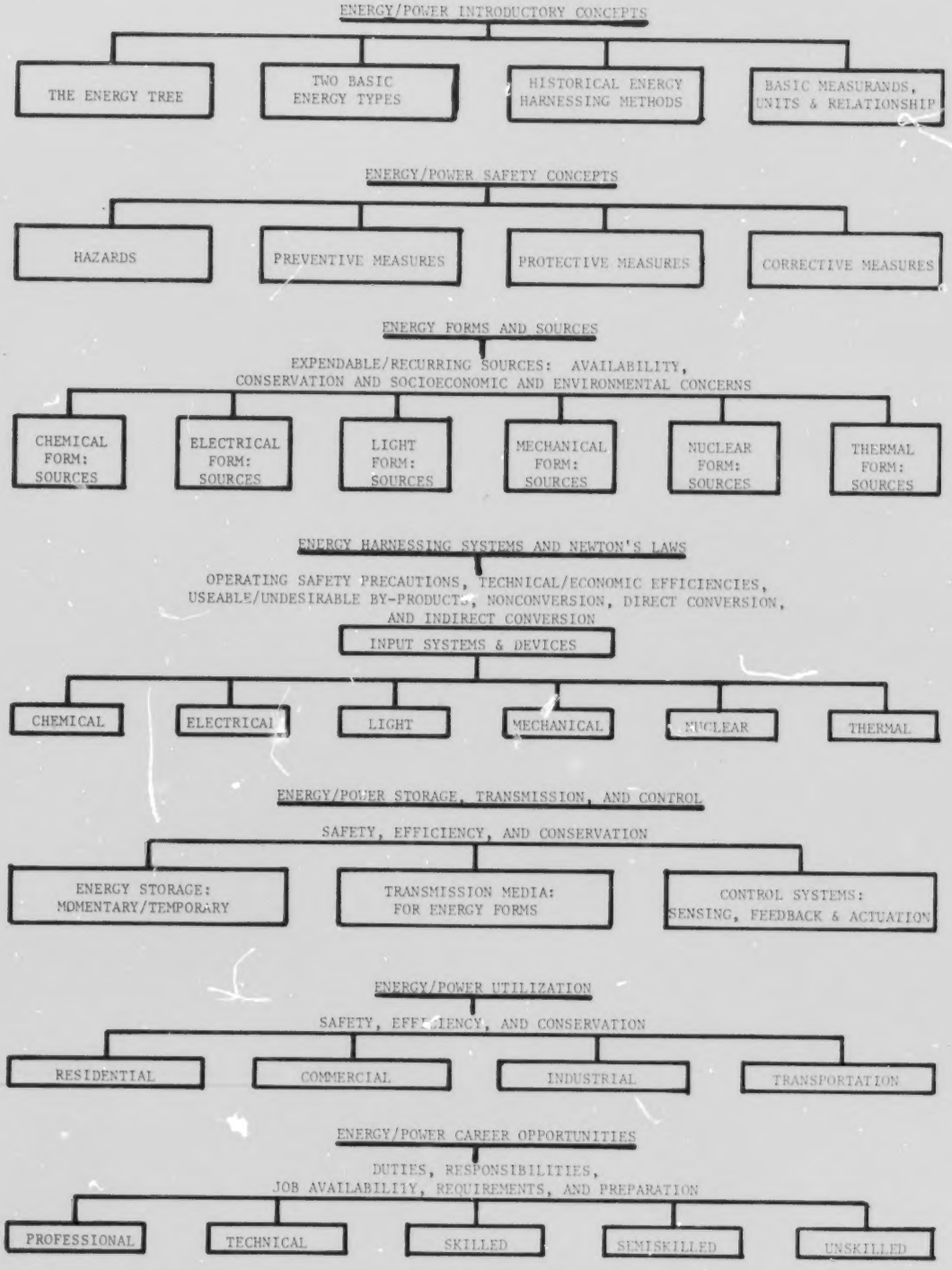
Several of the content units of this curriculum guide are followed by sketches of which may be used by the instructor and/or students to illustrate a few of the concepts contained in the "Body of Knowledge". Many additional illustrative devices may be found in texts listed in the Bibliography.

The implementation of the energy/power cluster in the classroom does not require vast amounts of additional expensive or technical equipment. The typical electricity/electronic and power laboratory

equipment should suffice. It must be remembered that most forms of energy have inherent danger factors, and the teacher of energy/power is cautioned to be ever mindful that his students are not accidently or inadvertently placed into a dangerous situation.

ENERGY/POWER TECHNOLOGY

TAXONOMETRIC STRUCTURE



ENERGY/POWER TECHNOLOGY

BODY OF KNOWLEDGE

1.00 ENERGY/POWER INTRODUCTORY CONCEPTS

- 1.10 The Energy Tree (Sun as Origin)
  - 1.11 Light → heat →
  - 1.12 Chemical reaction → vegetation
  - 1.13 Chemical reaction → fossil fuels → etc.
  - 1.14 Conservation and research
- 1.20 Two Basic Energy Types
  - 1.21 Kinetic
  - 1.22 Potential
- 1.30 Historical Harnessing and Energy Uses
  - 1.31 Muscle power
  - 1.32 Water and wind
  - 1.33 Heat and steam
  - 1.34 Gravity
- 1.40 Basic Measurands, Basic and Derived Units, and Interrelationships
  - 1.41 Energy (Joule)
  - 1.42 Power (Watt)
  - 1.43 Force (Newton)
  - 1.44 Torgue (Newton Meter)
  - 1.45 Pressure (Pascal)
  - 1.46 Thermal energy (Calorie
  - 1.47 Mass, length, time, etc.

2.00 ENERGY/POWER SAFETY CONCEPTS

- 2.10 Hazards
  - 2.11 Chemical
  - 2.12 Electrical
  - 2.13 Mechanical
  - 2.14 Radiation (light and nuclear)
  - 2.15 Thermal
- 2.20 Preventive Measures
  - 2.21 Attitudes
  - 2.22 Knowledge of correct usage
  - 2.23 Equipment
  - 2.24 Facilities

2.30 Protective Measures
- 2.31 Apparel
- 2.32 Containering methods
- 2.33 Shielding (eyes, face, insulative, etc.)
- 2.34 Grounding and/or appropriate mounting

2.40 Corrective Measures
- 2.41 Extinguishers
- 2.42 Inhibitors
- 2.43 Neutralizers

3.00 ENERGY FORMS AND SOURCES

3.10 Chemical
- 3.11 Fossil fuels
  - 3.111 Coal
  - 3.112 Oil
  - 3.113 Natural gas
- 3.12 Biofuels
  - 3.121 Biomass (plant matter)
  - 3.122 Agriculture
  - 3.123 Aquaculture
  - 3.124 Methane
  - 3.125 Alcohol
  - 3.126 Wood

3.20 Electrical
- 3.21 Electrostatic
  - 3.211 Friction
  - 3.212 Lightning
- 3.22 Magnetic

3.30 Light
- 3.31 Solar
  - 3.311 Helochemical (photosynthesis)
  - 3.312 Helioelectrical (solar cells, etc.)
  - 3.313 Heliothermal (solar collectors)
- 3.32 Radioactive

3.40 Mechanical
- 3.41 Wind
  - 3.411 Climate and atmospheric conditions
  - 3.412 Wind driven generators and alternators
  - 3.413 Blades and hubs
- 3.42 Water
  - 3.421 Tidal
  - 3.422 Waves
  - 3.423 Measuring available water power
  - 3.424 Dams
  - 3.425 Channel, sluices and pipes
- 3.43 Gravitational

3.50 Nuclear
- 3.51 Atomic, radioactive
  - 3.511 Atomic theory
  - 3.512 Chemical energy
  - 3.513 Electrons and energy
  - 3.514 Nuclear fuels
  - 3.515 Reactor principle and power
- 3.52 Solar
  - 3.521 Energy of sun
  - 3.522 Energy of radioactivity
  - 3.523 Nuclear fission
  - 3.524 Nuclear fusion

3.60 Thermal
- 3.61 Geothermal
- 3.62 Solar
- 3.63 Cryogenic (super cold)

4.00 ENERGY HARNESSING SYSTEMS AND NEWTON'S LAWS

4.10 Nonconversion, Direct Conversion, and Indirect Conversions
- 4.11 Law of conservation of energy

4.20 Chemical Energy Input
- 4.21 Fuel cell
- 4.22 Batteries
- 4.23 Fusion
- 4.24 Fission
- 4.25 Sun
- 4.26 Chemical heaters
- 4.27 Internal combustion engines
  - 4.271 Rocket
  - 4.272 Jet
  - 4.273 Turbojet
  - 4.274 Fan-jet
  - 4.275 Turbo-prop
  - 4.276 Diesel
  - 4.277 Gas and gas turbines
- 4.28 External combustion engine
  - 4.281 Steam (piston and turbine)
  - 4.282 Sterling
- 4.29 Chemical explosives
  - 4.291 Black powder
  - 4.292 Detonating explosives

4.30 Mechanical Energy Input
- 4.31 Pneumatic driven
  - 4.311 Wind Turbine
    - 4.3111 Air motor
    - 4.3112 Windmill

4.312 Sail and sailboats
4.313 Piston devices
4.3131 Jack hammer
4.32 Hydraulic driven
4.321 Water Turbine
4.322 Hydraulic motor
4.323 Piston devices
4.3231 Shock absorbers or adjustable screen door closers
4.3232 Hydraulic ram
4.33 Pexioelectric effect
4.34 Electric generator and alternators

4.40 Electrical Energy Input
4.41 Motors
4.42 Selenoids
4.43 Speakers
4.44 Nichrome wire heating element
4.45 Crystal
4.46 Radio
4.47 Television
4.48 Heaters
4.49 Lights
4.410 Refridgerator systems
4.411 Laser
4.412 Light emitting diode (LED)
4.413 Vacuum tubes
4.414 Semiconductors
4.415 Magnetohydrodynamic generator
4.416 Microwave ovens
4.417 Etc.

4.50 Nuclear Energy Input
4.51 Nuclear reactors
4.52 Radioactive isotopes
4.53 X-rays
4.54 Nuclear battery

4.60 Thermal Energy Input
4.61 Thermostat
4.62 Thermocouple (thermoelectric generator)
4.63 Thermoinic device
4.64 Boiling (water/steam)
4.65 Heat radiation
4.66 Thermophotovoltaic converter (TPV) (solar dwelling)

4.70 Light Energy Input
4.71 Photovotaic cell (solar cell)
4.72 Photoconductive cell
4.73 Photosynthesis (solar dwelling)

5.00 ENERGY/POWER STORAGE, TRANSMISSION AND CONTROL

- 5.10 Storage of Energy
  - 5.11 Momentary
    - 5.111 Ignition coil
    - 5.112 Capacitor
    - 5.113 Metal spring
    - 5.114 Etc.
  - 5.12 Temporary
    - 5.121 Battery
    - 5.122 Dam
    - 5.123 Heat storage tank
    - 5.124 Shielded nuclear storage device
    - 5.125 Etc.

- 5.20 Media of Transmission
  - 5.21 Electrical energy
    - 5.211 Gas or vacuum media
      - 5.2111 Electromagnetic waves
      - 5.2112 Lamps
      - 5.2113 Tubes
      - 5.2114 Etc.
    - 5.212 Solid media
      - 5.2121 Conductors, wires, etc.
      - 5.2122 Semiconductors, solid state, etc.
    - 5.213 Liquid media
      - 5.2131 Electroplating
      - 5.2132 Ionization
      - 5.2133 Etc.
  - 5.22 Light energy
    - 5.221 Gas or vacuum media
      - 5.2211 Electromagnetic radiation
      - 5.2212 Etc.
    - 5.222 Solid media
      - 5.2221 Transparent materials (glass transmission cable)
      - 5.2222 Translucent materials
    - 5.223 Liquid (crystal display devices)
  - 5.23 Thermal energy
    - 5.231 Gas media
      - 5.2311 Conduction, convection, and radiation
    - 5.232 Solid
      - 5.2321 Conduction
    - 5.233 Liquid
      - 5.2331 Conduction and convection
  - 5.24 Mechanical energy
    - 5.241 Gas media
      - 5.2411 Wind turbine (windmill)
      - 5.2412 Sails
      - 5.2413 Pneumatic driven and piston devices

5.242 Solid media
5.2421 Belts and drive chains
5.2422 Cams
5.2423 Levers
5.2424 Screws
5.2425 Wheel and axle
5.2426 Couplings
5.2427 Linkages
5.2428 Explosives
5.243 Liquid media
5.2431 Water Turbine
5.2432 Hydraulic driven and piston devices
5.25 Chemical energy
5.251 Gas media (fuel cell)
5.252 Solid media (dry cell)
5.253 Liquid media (wet cell)
5.26 Nuclear energy
5.261 Gas media (reactor principle)
5.262 Solid media (oblation principle)
5.263 Liquid media

5.30 Control Systems
5.31 Sensing and sensors (for control purposes)
5.311 Sensed information
5.3111 Quantatative sensing
5.3112 Qualitative sensing
5.312 Chemical sensors
5.3121 PH meter (senses ion concentration)
5.3122 Galvanometer (senses potential between metals in an electrolyte solution)
5.3123 Smoke detectors
5.313 Electrical sensors
5.3131 Relay (senses quantity of current)
5.3132 Galvanometer (senses minute voltages)
5.3133 Ammeter
5.3134 Oscilloscope
5.314 Light sensors
5.3141 Photovoltaic (solar) cell
5.3142 Photoconductive cell
5.315 Mechanical sensors
5.3151 Plumb bob
5.3152 Proving ring
5.3153 Strain gauge
5.3154 Pressure gauge (pop-off valve, manometer, etc.)
5.316 Nuclear sensors
5.3161 Geiger counter

5.317 Thermal sensors
5.3171 Thermostat
5.3172 Thermocouple

6.00 ENERGY/POWER UTILIZATION (Emphasis on safe, efficient and conservative use in all of the below indicated applications).

6.10 Residential
6.11 Light energy
6.111 Illumination
6.112 Sensing (alarms, etc.)
6.113 Viewing (TV)
6.114 Ultraviolet lamps
6.12 Thermal energy
6.121 Heating and cooling
6.122 Liquid and food refridgeration and heating
6.123 Heat lamps
6.13 Mechanical energy
6.131 Motor driven appliances and tools
6.132 Engine driven devices
6.133 Door activation mechanisms
6.14 Nuclear energy
6.141 Gaseous detection

6.20 Commercial (services and products are distributed)
6.21 Light energy
6.211 Illumination
6.212 Sensing (alarms, etc.)
6.213 Image development and viewing (film development and TV)
6.22 Thermal energy
6.221 Heating and cooling
6.222 Substance heating (ovens, torches, etc.)
6.223 Drying
6.23 Mechanical energy
6.231 Pneumatic driven (motor, piston and turbine devices)
6.232 Hydraulic driven (motor, piston and turbine devices)
6.233 Electric driven (solenoids, motors, etc.)
6.24 Nuclear energy
6.241 Medical and food treatment
6.242 Gaseous detection
6.30 Industrial (products are produced)
6.31 Light energy
6.311 Illumination
6.312 Sensing
6.32 Thermal energy
6.321 Climate control
6.322 Substance heating

6.33 Mechanical energy
- 6.331 Pneumatic driven
- 6.332 Hydraulic driven
- 6.333 Electric driven

6.34 Nuclear energy
- 6.341 Inspection
- 6.342 Electrical production

6.40 Transportation

6.41 Air or space
- 6.411 Internal combustion (piston, rocket, turbine)

6.42 Surface
- 6.421 Internal combustion engines
- 6.422 External combustion engines
- 6.423 Electrical
- 6.424 Gravitational
- 6.425 Muscle

6.43 Water
- 6.431 Internal combustion engines
- 6.432 Nuclear
- 6.433 Muscle
- 6.434 Electrical
- 6.435 Wind rotor

7.00 ENERGY/POWER CAREER OPPORTUNITIES
(Emphasis on duties, responsibilities, main job requirements and training programs--and including the concept of intercatagory assignments, i.e., the technician can contribute skills in the areas of servicing, research and development, maintenance, etc.)

7.10 Professional
- 7.11 Engineer/designer
- 7.12 Inventor
- 7.13 Researchers/scientists
- 7.14 Educators
- 7.15 Executives/managers

7.20 Technical
- 7.21 Quality/production supervisor
- 7.22 Engineering assistant
- 7.23 Superintendent/foreman
- 7.24 Drafting/design personnel
- 7.25 Experimental personnel

7.30 Skilled
- 7.31 Electricians
- 7.32 Assemblers
- 7.33 Machinists

7.40 Semi-skilled
- 7.41 On-the-job trainees
- 7.42 Self-improved workers

7.50 Unskilled
- 7.51 Helpers
- 7.52 Laborers
- 7.53 Attendants

ENERGY/POWER TECHNOLOGY

MAJOR UNITS

1.00	ENERGY/POWER INTRODUCTORY CONCEPTS	5 Days
2.00	ENERGY/POWER SAFETY CONCEPTS	3 Days
3.00	ENERGY FORMS AND SOURCES	12 Days
4.00	ENERGY HARNESSING SYSTEMS AND NEWTON'S LAWS	50 Days
5.00	ENERGY/POWER TRANSMISSION AND CONTROL	10 Days
6.00	ENERGY/POWER UTILIZATION	5 Days
7:00	ENERGY/POWER CAREER OPPORTUNITIES	3 Days

UNIT I

1.00 ENERGY/POWER INTRODUCTORY CONCEPTS 5 Days

OBJECTIVES: At the end of this unit, the student will be able to:

1. Describe how the sun is the origin of all organic energy.
2. Distinguish between kinetic and potential types of energy.
3. List and describe the historical methods of harnessing energy.
4. List, describe, and use the basic measurands and units associated with energy/power technology and their interrelationships.

UNIT OUTLINE

1.10 The Energy Tree (sun as origin)

1.11 Light → heat →

1.12 Chemical reaction → vegetation →

1.13 Chemical reaction → fossil fuels → etc.

1.20 Two Basic Energy Types

1.21 Kinetic

1.22 Potential

1.30 Historical Harnessing and Energy Uses

1.31 Muscle power

1.32 Water and wind

1.33 Heat and steam

1.34 Gravity

1.40 Basic Measurands, Basic and Derived Units and Interrelationships

1.41 Energy (Joule)

1.42 Power (Watt)

1.43 Force (Newton)

1.44 Torque (Newton Meter)

1.45 Pressure (Pascal)

1.46 Thermal energy (calorie)

1.47 Mass, Length, time, etc.

TEXT: Bohn, Ralph C. and MacDonald, Angus J., POWER: MECHANICS OF ENERGY CONTROL, McKnight and McKnight Publishing Co., Bloomington Illinois, 1970. Chapters 1 and 7.

REFERENCES: Editors of Power, POWER-GENERATION SYSTEMS, McGraw-Hill Book Co., New York, New York, 1967. PP. 139-148.

Duffy, Joseph W., POWER: PRIME MOVER OF TECHNOLOGY, 2nd Edition, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1972. PP. 1-49.

Sargent-Welch Scientific Co., THE METRIC SYSTEM AND SI MEASUREMENTS AND SYSTEM OF UNITS, Sargent-Welch Scientific Co., Skokie, Illinois, 1974. PP. 7-13.

UNIT NO. I	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
1.00	ENERGY/POWER INTRODUCTORY CONCEPTS THE STUDENT WILL BE ABLE TO:	
1.10	A. Identify, list and describe the natural progressions of energy from the sun into other forms of energy.	A1. Refer to A. at left. A2. Demonstrate the transformation of energy. Examples: Draw chart of energy tree with sun as origin.
1.20	A. Identify, list and describe the two basic types of energy.	A1. Identify examples of kinetic and potential energy in your lab, home, community, etc. A2. Discuss the law of conservation of energy. Examples: Demonstrate using pendulum. Drive nail and note temperature change of head. Light incandescent bulb and note temperature increase. (Approximately 10 percent of of electrical energy is converted to light energy and the remainder is converted to thermal energy.) A3. How friction interacts with the law of conservation of energy and how this effects the efficiency of a machine. Examples: Spin bicycle wheel, set rim brakes, and sense temperature of rim.

UNIT NO. I	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		Rub hands together with force and then put hands on face. Rapidly bend steel wire and note temperature change of wire.
		A4. Demonstrate how gravity effects the law of conservation of energy. Examples: Walking, using hand tools, bicycling, maintaining warmth, sailing, etc.
1.30	A. Identify and list a number of daily activities which are presently common to those activities of years ago.	A1. Refer to A. at left.
1.40	A. Differentiate and work with the basic measurands, units and mathematical interrelationships identified.	A1. Demonstrate and calculate torque with a torque wrench or bicycle crank.
		A2. Calculate how much horsepower a person develops in climbing a stairway in a measured period of time.
		A3. Demonstrate and calculate the mechanical advantage of different gear ratios on a speed bicycle.
		A4. Demonstrate and calculate the amount of force needed to lift one or more students using a spring scale on lever of a mechanical jack.

UNIT NO. I	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		A5. Demonstrate force needed to lift equal weights using various mechanical advantaged levers.

INSTRUCTOR AID

ENERGY/POWER INTRODUCTORY CONCEPTS

STEAM PRESSURE ATTENTION GETTER

Materials and Equipment Needed

1 Clean rectangular gallon tin can with good lid.

1 Teaspoon of water

1 Source of heat to create steam

Put 1 teaspoon of water into CLEAN gallon can. Heat till steam comes out of opening. Put cap on tight. Let cool. Can should collapse. Then reheat and watch can return to its original shape.

UNIT II

2.00 ENERGY/POWER SAFETY CONCEPTS 3 Days

OBJECTIVES: At the end of this unit, the student will have knowledge of the hazards, preventive measures, protective measures, and corrective measures essential to safe energy/power utilization.

UNIT OUTLINE

2.10 Hazards

- 2.11 Chemical
- 2.12 Electrical
- 2.13 Mechanical
- 2.14 Radiation (light and nuclear)
- 2.15 Thermal

2.20 Preventive Measures

- 2.21 Attitudes
- 2.22 Knowledge of correct usage
- 2.23 Equipment
- 2.24 Facilities

2.30 Protective Measures

- 2.31 Apparel
- 2.32 Containering methods
- 2.33 Shielding (eyes, face, insulative, etc.)
- 2.34 Grounding and/or appropriate mounting

2.40 Corrective Measures

- 2.41 Extinguishers

2.42 Inhibitors

2.43 Neutralizers

REFERENCES: Contact local or state fire marshal for literature.

UNIT NO. II	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
2.00	ENERGY/POWER SAFETY CONCEPTS THE STUDENT WILL BE ABLE TO:	
2.10	A. Identify the common types of hazards associated with energy/power usage.	A1. Exploration of your facility and discussion. A2. Guest speaker, city fire marshal or an electrician, and discussion.
2.20	A. List the preventive measures involved in safe utilization of energy/power.	A1. Role playing of personal attitudes. A2. Discuss and examine equipment. A3. Design and make safety posters for laboratory. A4. Exploration of your facility and discussion.
2.30	A. Recognize the appropriate protective measures in various energy/power situations.	A1. View demonstration and safety films and have participatory discussion.
2.40	A. Utilize the corrective measures in a needful situation.	A1. View demonstration and safety films and have participatory discussion.

UNIT III

3.00 ENERGY FORMS AND SOURCES 12 Days

OBJECTIVES: At the end of this unit, the student will be able to:

1. List the six forms of energy and list sources of each.
2. List and discuss the availability, shortages, and judicious conservation of energy resources, and the socioeconomic and environmental factors involved in the overall energy field.

UNIT OUTLINE

3.10 Chemical

3.11 Fossil fuels

3.111 Coal

3.112 Oil

3.113 Natural gas

3.12 Biofuels

3.121 Biomass (plant matter)

3.122 Argiculture

3.123 Aquaculture

3.124 Methane

3.125 Alcohol

3.126 Wood

3.20 Electrical

3.21 Electrostatic

3.211 Friction

3.212 Lightning

3.22 Magnetic

3.30 Light

3.31 Solar

3.311 Heliochemical (Photosynthesis)

3.312 Helioelectrical (solar cells, etc.)

3.313 Heliothermal (solar collectors)

3.32 Radioactive

3.40 Mechanical

3.41 Wind

3.411 Climate and atmospheric conditions

3.412 Wind driven generators and alternators

3.413 Blades and hubs

3.42 Water

3.421 Tidal

3.422 Waves

3.423 Measuring available water power

3.424 Dams

3.425 Channels, sluices and pipes

3.43 Gravitational

3.50 Nuclear

3.51 Atomic, radioactive

3.511 Atomic theory

3.512 Chemical energy

3.513 Electrons and energy

3.514 Nuclear fuels

3.515 Reactor principle and power

3.52 Solar

3.521 Energy of sun

3.522 Energy of radioactivity

3.523 Nuclear fission

3.524 Nuclear fusion

3.60 Thermal

3.61 Geothermal

3.62 Solar

3.63 Cryogenic (super cold)

TEXT: Bohn, Ralph C. and MacDonald, Angus J., POWER: MECHANICS OF ENERGY CONTROL, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1970. PP. 14, 117--119, and Chapter 7.

REFERENCES: Portola Institute, ENERGY PRIMER: SOLAR, WATER, WIND, AND BIOFUELS, Fricke-Parks Press Inc., Fremont, California, 1974. PP. 106--166.

UNIT NO. III	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
3.00	ENERGY FORMS AND SOURCES THE STUDENT WILL BE ABLE TO:	
	A. Identify the six forms of energy and sources of each.	A1. Explanation and demonstration.
	B. Identify the problems related to the resources, praticality of harnessing, and the economic and ecological implications related to the various forms/ sources of energy.	B1. Discussion of energy reserves (newspaper articles); examine local and national ecological standards and controls. B2. Discuss and examine economic and social impacts of developing a nearby dam, refinery, coalfield, etc.
	C. Generalize from related information man's changing dependence on the forms of energy.	C1. Explain and demonstrate the depletion or supply and demand of fossil fuels in our society.
	D. Identify the main safety hazard concerns inherent in each form of energy.	D1. Discuss current events and relate to safety hazards, coal mines, cave-ins, water, air, noise pollution, technical advancements causing or curbing cancer, etc.
3.10	A. Identify, list and/or describe the three forms of fossil fuels as they relate to chemical energy.	A1. Examine the three forms of fossil fuels through readings, handouts, films, etc. A2. Field trip of a refinery, coal field, coal gasification plant, etc.: obtain samples.

UNIT NO. III	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		A3. Examine biofuels and their contribution to the energy scene. A4. Produce methane gas from the decomposition of body wastes, animal matter and/or plant matter as a long-term class project. A5. Produce methyl alcohol from the destructive distillation of high-cellulose organic wastes (wood and refuse) and distillation of liquid as a long-term class project. A6. Discuss and/or demonstrate agriculture and the means by which solar energy becomes our food energy as a long-term class project. A7. Discuss and/or demonstrate the cultivation and harvesting of fish and shellfish protein, and plants (seaweeds, watercress, water lettuce, algae, etc.) for human diet. A8. Discuss and/or demonstrate the production of methane in aerobic or anerobic environments as a long-term project. A9. Discuss and/or demonstrate the production of alcohol and its use as a form of energy for heating, cooking, lighting, motor fuel or liquor. A10. Discuss and/or demonstrate the efficient use of wood as a fuel, efficient use of fireplaces and stoves.

UNIT NO. III	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
3.20	A. Identify and describe the natural sources of electrical energy.	A1. Write report on cause and phenomenon of lightning.
	B. Name and describe the law of charges and how it is related to producing energy.	B1. Hold a neon bulb by one terminal, shuffle across rug on floor of room, touch other terminal to grounded metal object, and notice its effects.
		B2. Measure the relative magnetic qualities of a variety of metallic specimens using a magnet.
		B3. Experiment with magnetic fields and iron filings.
		B4. Experiment with the effects of a magnet on a compass.
		B5. Experiment with a cold rolled steel rod and iron filings to check the angle of inclination of your particular latitude.
3.30	A. Identify, list, and/or describe the fundamental principles of solar energy use.	A1. Refer to A. at left.
	B. Identify, list, and/or describe solar radiation and its uses on earth.	B1. Construct and experiment with one or more of the following: Solar stills Solar dryers Sun dials Solar cooling

UNIT NO. III	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		Solar air heating systems Solar furnaces Solar water and air heaters Solar space heating and heat storage Solar cooking
	C. Identify, list, and/or describe the use of the solar cell in our society and space program.	C1. Experiment with solar cell test unit. C2. View films on solar energy.
3.40	A. Identify, list and/or describe the causes of wind and how it relates to high and low pressure areas created by the sun.	A1. Gather data on temperature/winds/barometric pressure relationships. A2. Discuss and observe climate and atmospheric phenomena which causes weather. A3. Discuss and examine weather map. A4. Take a field trip or have a guest speaker from a weather bureau or a pilot as a guest speaker.
	B. Identify, list, and/or describe the conversion of wind energy from mechanical energy to electrical energy.	B1. View film on principle of wind turbine. B2. Construct and/or experiment with squirrel cage fan as a wind turbine.
	C. Identify, list, and/or describe ways of harnessing the power of water.	C1. Discuss, construct and/or experiment with the water wheel, and/or water turbine principles and how it relates to the production of power. Use water sprinkler motor.

UNIT NO. III	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
	D. Identify, list, and/or describe the environmental considerations, economics and geological affect water power has on society and geography.	D1. Field trip or guest speaker. (A local soil conservationist or resources conservation district, an agency of the U.S. Dept. of Agriculture, can usually be helpful in supplying information.)
	E. Identify, list, and/or describe the effect tides and waves, as an alternative power source, have on the future.	E1. Construct a wave tank and experiment with the effects of wave and tidal power.
	F. Identify, list and/or describe the effect the force of gravity has on potential and kinetic energy.	F1. Discuss, experiment with and/or demonstrate different examples, i.e. water in a reservoir, spillways, plumb bobs, acceller-ation due to gravity, resistance to gravity, mass and density, ect.
3.50	A. Identify, list, and/or describe the atomic theory, radioactivity and nuclear fission, and fusion.	A1. Films and discussion.
3.60	A. List and describe sources of thermal energy.	A1. Refer to A. at left.

UNIT IV

4.00 ENERGY HARNESSING SYSTEMS 50 Days

OBJECTIVES: At the end of this unit, the student will be able to:

1. List the methods by which each of the six forms of energy can be used in original form or be converted to other forms
2. Match the safety, environmental, and economic concerns with the harnessing system involved.

UNIT OUTLINE

4.10 Nonconversion, Direct Conversion, and Indirect Conversions

4.11 Law of conservation of energy

4.20 Chemical Energy Input

4.21 Fuel cell

4.22 Batteries

4.23 Fusion

4.24 Fission

4.25 Sun

4.26 Chemical heaters

4.271 Rocket

4.272 Jet

4.273 Turbojet

4.274 Fan-jet

4.275 Turbo-prop

4.276 Diesel

4.277 Gas and gas turbines

4.28 External Combustion engine

4.281 Steam (piston and turbine)

4.282 Sterling

4.29 Chemical explosives

4.291 Black powder

4.292 Detonating explosives

4.30 Mechanical Energy Input

4.31 Pneumatic driven

4.311 Wind Turbine

4.3111 Air motor

4.3112 Windmill

4.312 Sail and sailboats

4.313 Piston devices

4.3131 Jack hammer

4.32 Hydraulic driven

4.321 Water turbine

4.322 Hydraulic motor

4.323 Piston devices

4.3231 Shock absorbers or adjustable screen door closers

4.3232 Hydraulic ram

4.33 Perxioelectric effect

4.34 Electric generator and alternators

4.40 Electrical Energy Input

4.41 Motors

4.42 Selenoids

4.43 Speakers

4.44 Nichrone wire heating element

4.45 Crystal

4.46 Radio

4.47 Television

4.48 Heaters

4.49 Lights

4.410 Refridgerator systems

4.411 Laser

4.412 Light emitting diode (LED)

4.413 Vacuum tubes

4.414 Semiconductors

4.415 Magnetohydrodynamic generator

4.416 Microwave ovens

4.417 Etc.

4.50 Nuclear Energy Input

4.51 Nuclear reactors

4.52 Radioactive isotopes

4.53 X-rays

4.54 Nuclear battery

4.60 Thermal Energy Input

4.61 Thermostat

4.62 Thermocouple (thermoelectric generator)

4.63 Thermoinic device

4.64 Boiling (water/steam)

4.65 Heat radiation

4.66 Thermophotovoltaic converter (TPV) (solar dwelling)

4.70 Light Energy Input

4.71 Photovotaic cell (solar cell)

4.72 Photoconductive cell

4.73 Photosynthesis (solar dwelling)

TEXT: Bohn, Ralph C. and MacDonald, Angus J., POWER: MECHANICS OF ENERGY CONTROL, McKnight and McKnight Publishinc Co., Bloomington, Illinois, 1970. Chapter 6, pp. 158--165; Chapters 8 and 9, pp. 230--235.

REFERENCES: Turner, Rufus P., SOLAR CELLS AND PHOTOCELLS, Howard W. Sams and Co., Inc., Indianapolis, Indiana, 1975. Chapters 1, 2 and 3.

Portola Insitute, ENERGY PRIMER: SOLAR, WATER, WIND, AND BIOFUELS, Fricke-Parks Press Inc., Fremont, California, 1974. PP. 52-105.

Walker, John R., EXPLORING POWER TECHNOLOGY: BASIC FUNDAMENTALS, The Goodheart-Willcox Co., Inc., South Holland, Illinois, 1976. Chapter 6

Brochures and booklets from: Estes Industries, Inc., Penrose, Colorado 81240 on Model Rocketry.

UNIT NO. IV	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
4.00	ENERGY HARNESSING SYSTEMS THE STUDENT WILL BE ABLE TO:	
4.10	A. Identify whether nonconversion, direct conversion or indirect conversion are involved in various energy harnessing systems.	A1. Refer to A. at left.
4.20	A. Identify and list examples of various chemical energy input systems.	A1. Demonstrate the use of a fuel cell. A2. Connect automotive battery charger and collect hydrogen given off by charging as per instruction sheet at end of this unit. A3. View film on nuclear fusion and/or fission. A4. View film on sun (Bell Telephone, "Our Mr. Sun"). A5. View transparent engine in operation under various loads and compare results of dynomometer output. A6. Small engine analysis sequence. Record owner's comments on engine performance. Test engine under load and observe performance. List possible defects and needed repairs. Test and record engine compression.

4.5

UNIT NO. IV	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		Clean engine. Record carburetor settings and linkages for reassembly purposes Record ignition settings. Disassemble engine as needed. Measure and record data of crankshaft, camshaft, piston, and valve assemblies. Compare measurements with manufacturer's tolerances and replace parts as needed. Recondition valves and cylinder as needed. Reassemble engine following manufacturer's tolerance and torque specifications. Retest engine under load making appropriate carburetor and other adjustments. Write report on procedures followed including original faults, corrective measures taken, and final engine performance.
		A7. Construct and test fire rockets.
		A8. Observe chemical light stick. (Sears Roebuck Co. is one source.)
4.30	A. Identify and list examples of various mechanical energy input systems.	A1. Experiment with impact wrench or air motor in operation observing pressure, speed, and torque.
		A2. Attach model airplane propeller to tachometer generator and measure output voltage versus propeller speed.

4.6

UNIT NO. IV	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		A3. Experiment with squirrel cage fan as wind turbine.
		A4. Experiment with lawn sprinkler motor observing pressure, speed, and torque.
4.40	A. Identify and describe the principles involved in various simple electrical energy input systems.	A1. Experiment with simple 1-2- or 3-Transistor radio circut.
		A2. Experiment with motor speed control and/or light dimmer having a triac or silicon-controlled-rectifier as the controlling element.
		A3. View film on magnetohydrodynamic generator.
		A4. Under various loads compare amperage requirements for an electrical motor.
		A5. Experiment with a doorbell, aquarium pump, or automotive starter solenoid.
		A6. Experiment using a loud speaker and 1 dry cell or a low voltage AC source.
		A7. Construct a styrofoam cutter.
		A8. Experiment with non-powered crystal detector with earphones.
		A9. Experiment with series and parallel hookups of lights

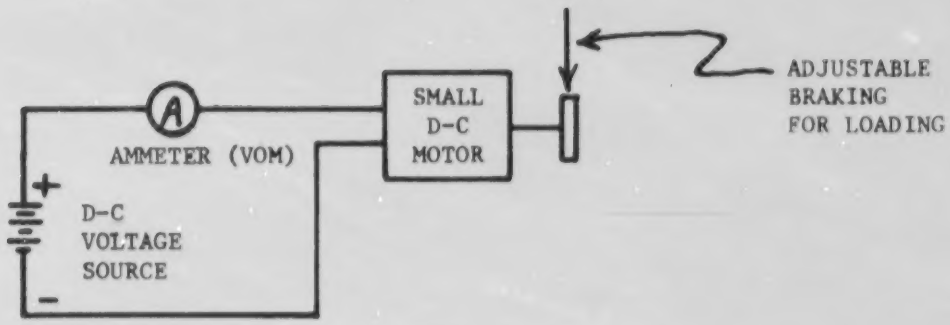
4.7

UNIT NO. IV	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		A10. View film on laser principles.
4.50	A. Identify and list examples of various nuclear energy input systems.	A1. View film on nuclear reactors. A2. Observe use of geiger-counter (contact civil defense representative).
4.60	A. Indentify and list examples of various thermal energy input systems.	A1. Observe opening and closing of an automotive radiator or house thermostat under varying temperatures. A2. Experiment with and/or demonstrate a thermo-electric generator or series-connected thermocouples. (Use thermoelectric generator if available.)
4.70	A. Identify and list examples of various light energy input systems.	A1. Measure electrical output of solar cell in sun light, a lighted room, and subdued light. A2. Experiment with photoconductive cells, such as phototransister with a relay. A3. Grow plants in lighted and unlighted areas and observe color differences. A4. Discuss plant breathing such as in a terrarium.

INSTRUCTOR AID

ENERGY HARNESSING SYSTEM

ELECTRICAL ENERGY INPUT
MECHANICAL ENERGY OUTPUT



NOTES:
1. Source voltage must be compatible with motor rating.
2. Range of ammeter must be compatible with current drawn by motor when under load.
3. Braking system suggested to consist of two to four inch diameter pulley, piece of leather for contact, and adjustable spring tension for varying loads.

Suggested motor sources are: Automobile heater fan motor (draws considerable current)

Portable tape recorder motor (draws low value of current)

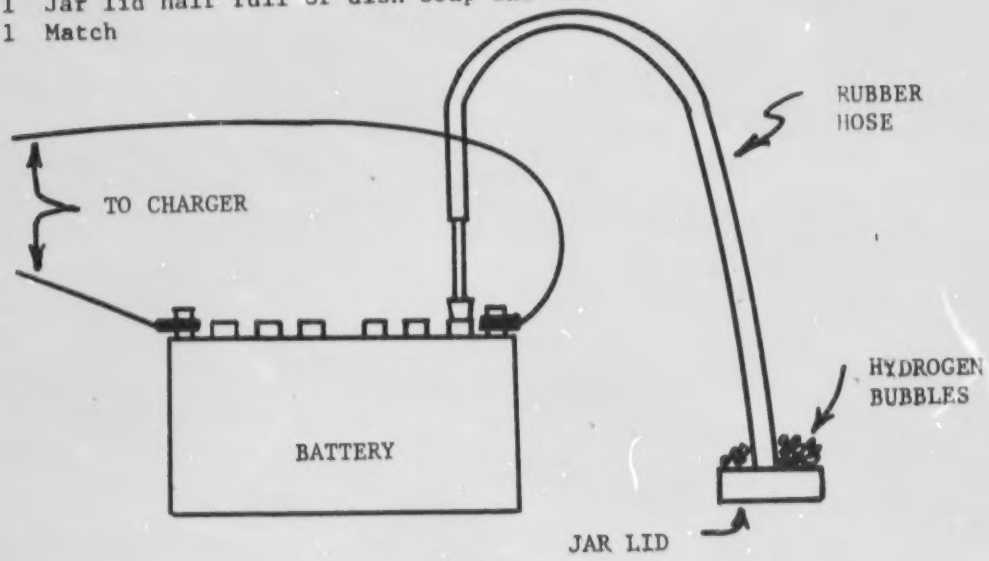
INSTRUCTOR AID

ENERGY HARNESSING SYSTEMS

HYDROGEN PRODUCTION

MATERIALS AND EQUIPMENT NEEDED

1 Automotive battery
1 Battery charger
1 Rubber stopper with hole for glass tube
1 2" glass tube
1 2' rubber hose
1 Jar lid half full of dish soap and water
1 Match



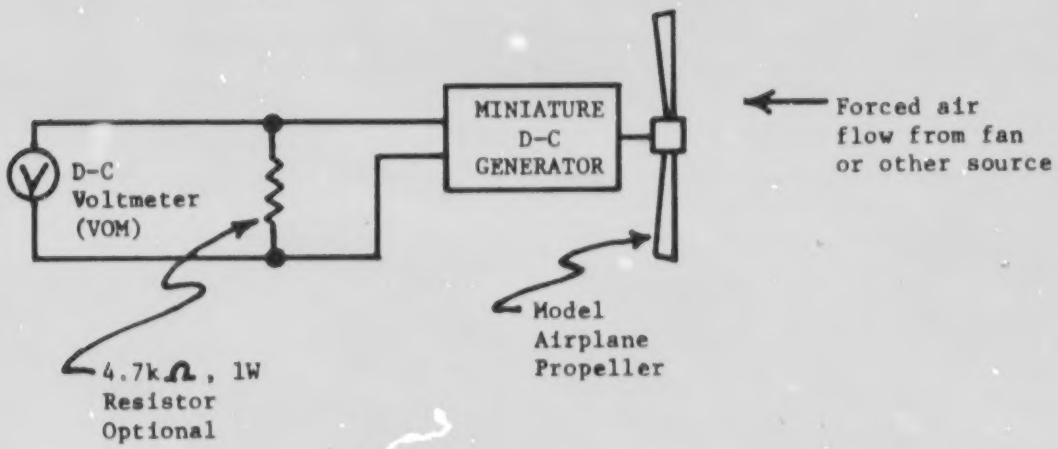
Start battery charger. Take off one of the caps. Put rubber stopper into cell opening. Hook up rubber hose and get a good head of hydrogen bubbles in jar lid.

REMOVE JAR LID WITH HYDROGEN BUBBLES AT LEAST 10' FROM BATTERY.

Bring lighted match close to hydrogen bubbles to cause ignition. Impress upon students the proper way to hook up jumper cables when starting a car.

INSTRUCTOR AID

ENERGY HARNESSING SYSTEM
MECHANICAL ENERGY INPUT
ELECTRICAL ENERGY OUTPUT



NOTES: 1. Voltage output may be varied by varying air flow to propellor

2. Polarity of voltage output is determined by rotatation direction on most minature generators.

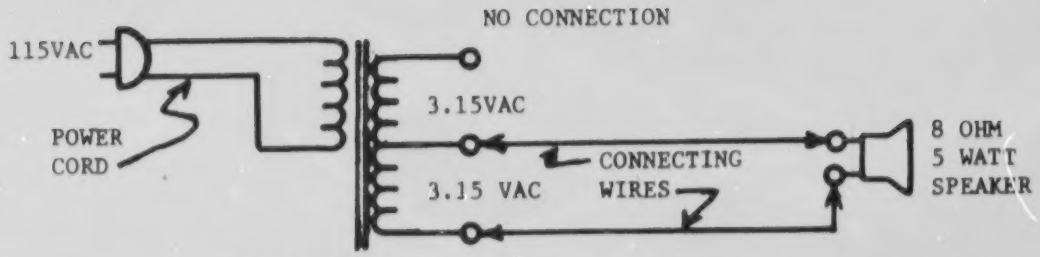
One suggested generator is: Zero-Max Company
Model B2

Output voltage: 6 volts at 1000 RPM

INSTRUCTOR AID

ENERGY HARNESSING SYSTEM

ELECTRICAL ENERGY INPUT
MECHANICAL ENERGY OUTPUT



TRANSFORMER
PRIMARY 115 VAC
SECONDARY 6.3 VAC CENTER TAPPED

NOTES: 1. Transformer MUST be covered and all connection points properly terminated for safety during use.

2. Connections to the speaker should be of short duration to prevent heating of speaker coil due to the single tone being generated.

INSTRUCTOR AID

ENERGY HARNESSING SYSTEMS

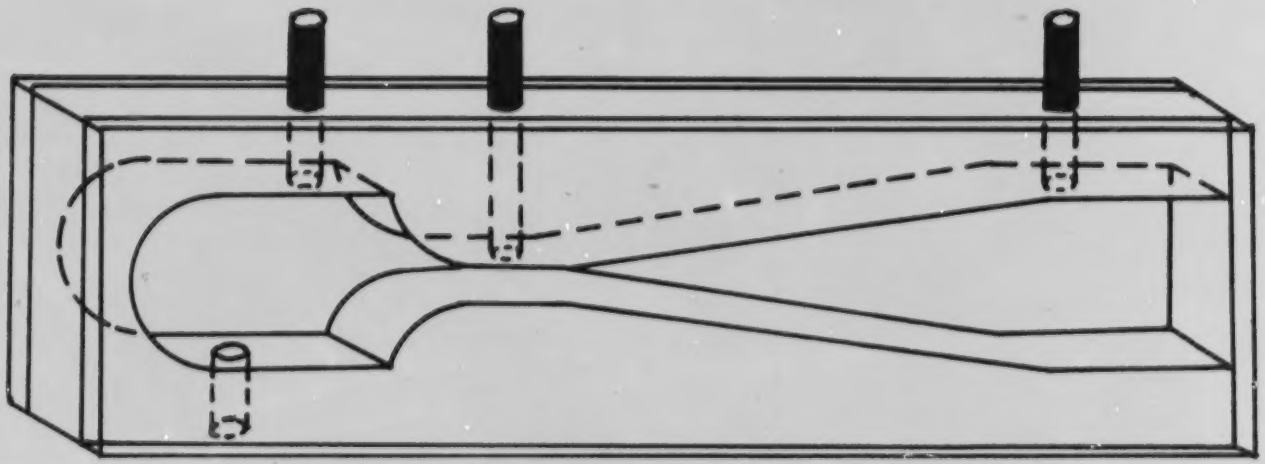
LABORATORY APPARATUS FOR DEMONSTRATING BERNOULLI'S THEOREM

MATERIALS AND EQUIPMENT NEEDED

2 Pieces 1/4" plexiglass or clear acrylic
1 Piece 3/8" plywood

PROCEDURE OF CONSTRUCTION

1. Cut materials as per drawing, glue together.
2. Drill holes for 1/4" copper pipes.



DIRECTIONS: Air entered into orifice A will, when traveling out exhaust D create a measurable drop in pressure at orifice B and C. Vacuum gauge available at Auto Supply Store or Government Surplus.

INSTRUCTOR AID

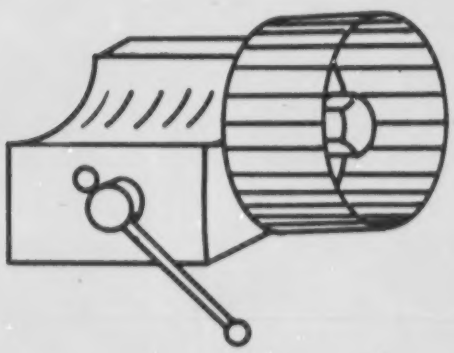
ENERGY HARNESSING SYSTEMS

ACTIVITY TO SUPPORT TURBINE INTRODUCTION LESSONS

MATERIALS AND EQUIPMENT NEEDED

1 Vise
1 2" 5/16 cap screw with nut
1 Squirrel cage fan from old auto heater blower
Flat washers or appropriate spacers

Assemble as in diagram:
(Secure to vise very tightly)



NOTE: When using bolt and spacers to secure fan to vise, a few drops of oil will almost double rotational speed possible.

OPERATION AND DEMONSTRATION: Using air supply with blower nozzle the cage can be rotated at extremely high speed, each blade contributing its small amount of power, many times each minute, which is the main advantage of turbines of all types.

CAUTION: POSITIVELY FORBID ANYONE FROM STANDING IN LINE WITH THE ROTATING CAGE!

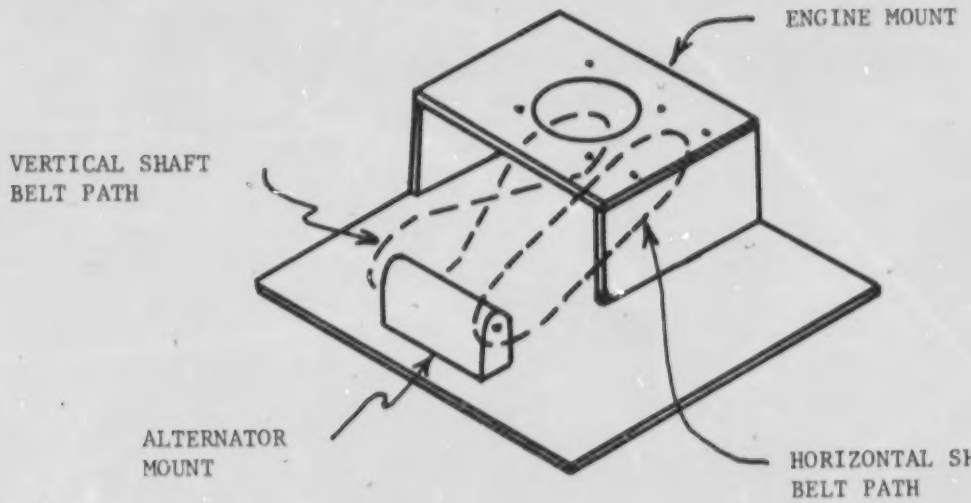
INSTRUCTOR AID

ENERGY HARNESSING SYSTEMS

SMALL ENGINE DYNOMOMETER USING ALTERNATOR/LIGHT-BULB LOAD

MATERIALS AND EQUIPMENT NEEDED

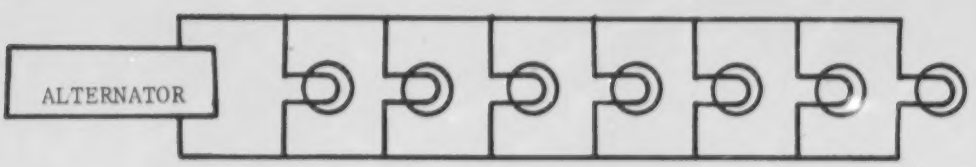
3/4" construction plywood



Directions for mounting vertical or horizontal crank, small engine, and 60 amp auto alternator.

Vertical shaft engines mounted with shaft down through hole; bolted, with alternator fastened to alternator mount with pulley in line with shaft.

ALTERNATOR LOADING SCHEMATIC



NOTE: Twelve-volt (highest available wattage) bulbs loosened or tightened in their sockets to load alternator. Total power (sum of bulbs' wattages) must NOT exceed alternator's current rating times voltage rating, e.g., 60A x 12V = 720W.

UNIT V

5.00 ENERGY/POWER TRANSMISSION AND CONTROL 10 Days

OBJECTIVES: At the end of this unit, the student will have the:

1. Ability to discuss or list the methods and systems or devices which can store various forms of energy.
2. Knowledge to list the methods whereby energy is transmitted to the consumer.
3. Ability to name or list five methods of controlling energy use with their practicality, safety, environmental, and efficiency concerns.

UNIT OUTLINE

5.10 Storage of Energy

5.11 Momentary

5.111 Ignition coil

5.112 Capacitor

5.113 Metal spring

5.114 Etc.

5.12 Temporary

5.121 Battery

5.122 Dam

5.123 Heat storage tank

5.124 Shielded nuclear storage device

5.125 Etc.

5.20 Media of Transmission

5.21 Electrical energy

5.211 Gas or vacuum media

5.2111 Electromagnetic waves

5.2112 Lamps

5.2113 Tubes

5.2114 Etc.

5.212 Solid media

5.2121 Conductors, wires, etc.

5.2122 Semiconductors, solid state, etc.

5.213 Liquid media

5.2131 Electroplating

5.2132 Ionization

5.2133 Etc.

5.22 Light energy

5.221 Gas or vacuum media

5.2211 Electromagnetic radiation

5.2212 Etc.

5.222 Solid media

5.2221 Transparent materials (glass transmission cable)

5.2222 Translucent materials

5.223 Liquid (crystal display devices)

5.23 Thermal energy

5.231 Gas media

5.2311 Conduction, convection, and radiation

5.232 Solid

5.2321 Conduction

5.233 Liquid

5.2331 Conduction and convection

5.24 Mechanical energy

5.241 Gas media

5.2411 Wind turbine (windmill)

5.2412 Sails

5.2413 Pneumatic driven and piston devices

5.242 Solid media

5.2421 Belts and drive chains

5.2422 Cams

5.2423 Levers

5.2424 Screws

5.2425 Wheel and axle

5.2426 Couplings

5.2427 Linkages

5.2428 Explosives

5.243 Liquid media

5.2431 Water Turbine

5.2432 Hydraulic driven and piston devices

5.25 Chemical energy

5.251 Gas media (fuel cell)

5.252 Solid media (dry cell)

5.253 Liquid media (wet cell)

5.26 Nuclear energy

5.261 Gas media (reactor principle)

5.262 Solid media (oblation principle)

5.263 Liquid media

5.30 Control Systems

5.31 Sensing and sensors (for control purposes)

5.311 Sensed information

5.3111 Quantatative sensing

5.3112 Qualitative sensing

5.312 Chemical sensors

5.3121 PH meter (senses ion concentration)

5.3122 Galvanometer (senses potential between metals in an electrolyte solution)

5.2123 Smoke detectors

5.313 Electrical sensors

5.3131 Relay (senses quantity of current)

5.3132 Galvanometer (senses minute voltages)

5.3133 Ammeter

5.3134 Oscilloscope

5.314 Light sensors

5.3141 Photovoltaic (solar) cell

5.3142 Photoconductive cell

5.315 Mechanical sensors

5.3151 Plumb bob

5.3152 Proving ring

5.3153 Strain gauge

5.3154 Pressure gauge (pop-off valve, manometer, etc.)

5.316 Nuclear sensors

5.3161 Geiger counter

5.317 Thermal sensors

5.3171 Thermostat

5.3172 Thermocouple

TEXT: Bohn, Ralph C. and MacDonald, Angus J., POWER: MECHANICS OF ENERGY CONTROL, McKnight and McKnight Publishing Co., Bloomington Illinois, 1970. Chapters 2, 3, 4, and 6.

REFERENCES: Suess, Alan R., Dugger, William E., Patrick, Dale R., and Ziegler, James T., INTRODUCTION TO POWER SYSTEMS, Bruce Publishing Co., Beverly Hills, 1976. PP. 141--159.

Turner, Rufus P., SOLAR CELLS AND PHOTOCELLS, Howard Sams and Co., Inc., Indianapolis, Indiana, 1975. Chapter 3.

UNIT NO. V	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
5.00	ENERGY/POWER STORAGE, TRANSMISSION AND CONTROL THE STUDENT WILL BE ABLE TO:	
5.10	A. Identify and list a variety of energy storage devices, the form of energy stored by each, and some commonly found instances of their use.	A1. Experiment with momentary storage using 12-volt battery, knife switch, ignition coil, and spark plug. A2. Experiment with large capacitor, low-voltage source, and low-voltage minature D-C motor.
5.20	A. Identify the categories of media of transmission and common applications and devices or materials used or each.	A1. Demonstrate or experiment with centertapped secondary transformer, observing effects of balanced and unbalanced loads, with single-side and full-secondary loading, to simulate an electrical power transmission system. A2. Demonstrate electroplating. A3. Demonstrate holography principles (check with physics department). A4. Demonstrate fiber optics. A5. Demonstrate convention, conduction, and radiation of thermal energy using pre-heated piece of metal or radiator.

5.6

UNIT NO. V	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		A6. View film on principles of automobile radiator as cooling system. A7. Demonstrate or view film regarding air-driven motor, jack hammer, etc., wherein air is media of transmission. A8. Experiment with belt-pulleys, gears, etc. and determine speed of shaft ratios and torque ratios involved. A9. Using assigned RPM of peddles of a multi-speed bike, determine resulting rear wheel speeds.
5.30	A. Identify and list various categories of sensors as per energy forms and list devices which belong in each category.	A1. Demonstrate PH meter (see chemistry dept.) usage on such solutions as electrolyte of lead-acid battery, river water, salt water, drinking water, distilled water, etc. A2. Experiment with various dissimilar metals immersed in solutions by measuring galvanic potential using galvanometer or sensitive voltmeter. A3. Experiment with relay, rheostat, and ammeter connected in series with low-voltage D-C source to determine pull-in and drop-out current levels of [illegible] A4. Demonstrate and explain purpose and functional operation of vane-type governor on small gasoline engine.

5.7

UNIT NO. V	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
		A6. Demonstrate simple nichrome-wire strain gauge. A7. Construct and experiment with simple water manometer. A8. Demonstrate operation of thermostat connected with low-voltage source and small lamp (for output indication) by cooling and warming thermostat element for several different temperature dial settings. A9. Demonstrate thermocouple use in temperature sensing using series-connected thermocouple elements and a galvanometer or sensitive voltmeter.

5.8

INSTRUCTOR AID

ENERGY STORAGE SYSTEM

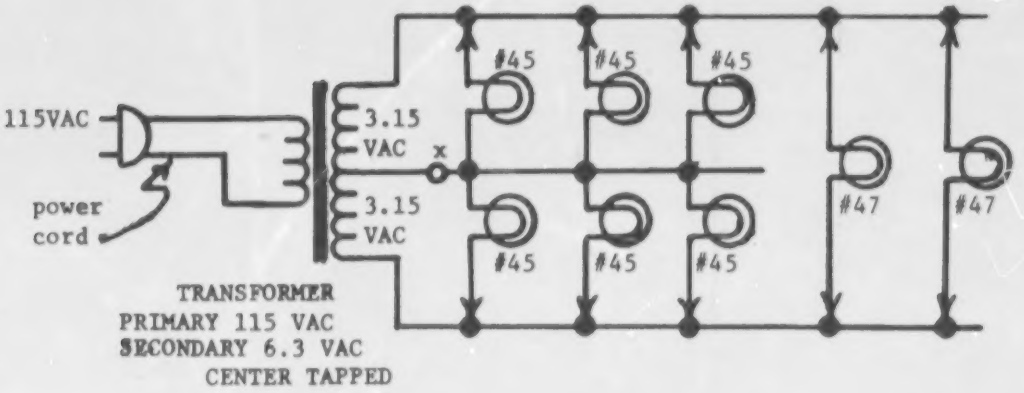
ELECTRICAL FIELD ENERGY STORAGE

NOTES:
1. Battery voltage must be compatible with voltage rating of motor.
2. Connect C (approximately 2,000 uF @ 15 volts) to battery to permit storage of electrostatic field energy.
3. QUICKLY disconnect C from battery and connect to motor. Stored electrostatic field energy will be converted to mechanical energy of motor.

INSTRUCTOR AID

ENERGY TRANSMISSION (DISTRIBUTION) SYSTEM

THREE-WIRE ELECTRICAL DISTRIBUTION SYSTEM
(Simulates the 115 volt and 230 volt system used in residences and other customer applications)



NOTES:

1. Transformer MUST be covered and all connection points properly terminated for safety during use.

2. The arrows on lamp connections indicate that any of the lamps may be connected or removed to observe effects of loading.

3. The #45 lamps simulate the 115 volt lights and appliances of a residence and the #47 lamps simulate the 230 volt appliances, such as cooking range, clothes dryer, arc welder, which require such voltage.

4. Opening the "neutral" (center tap wire at point X) when the quantity of #45 lamps on the upper side EQUALS the quantity of #45 lamps on the lower side will not cause a change, which indicates a BALANCED LOAD which is the desired condition.

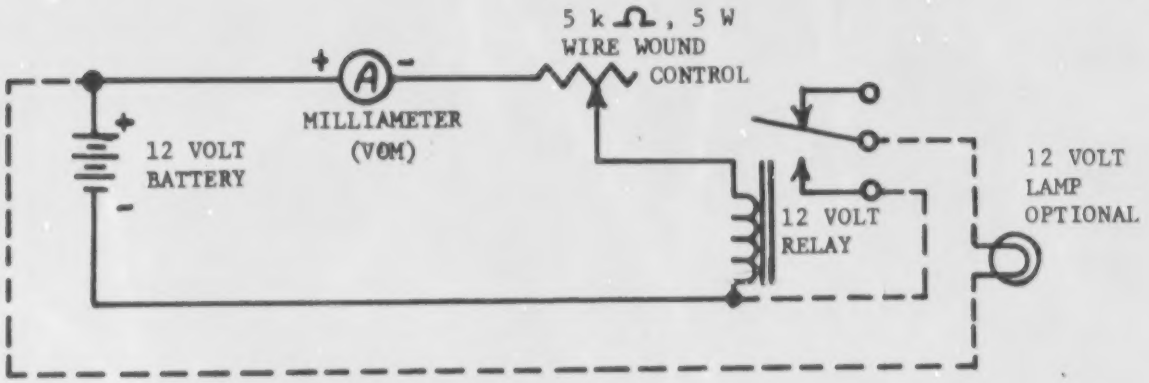
   Opening the "neutral" when an UNEQUAL quantity of #45 lamps are on the two sides will cause at least a slightly visible change in brightness of the various lamps, which indicates an UNBALANCED LOAD.

   Since the #47 lamps are connected across the outer lines, their brightness will not be effected by imbalance of loads on the sides.

INSTRUCTOR AID

ENERGY SENSING AND CONTROL

USING RELAY TO ILLUSTRATE
CURRENT LEVEL SENSING
AND RESULTANT RELAY ACTION



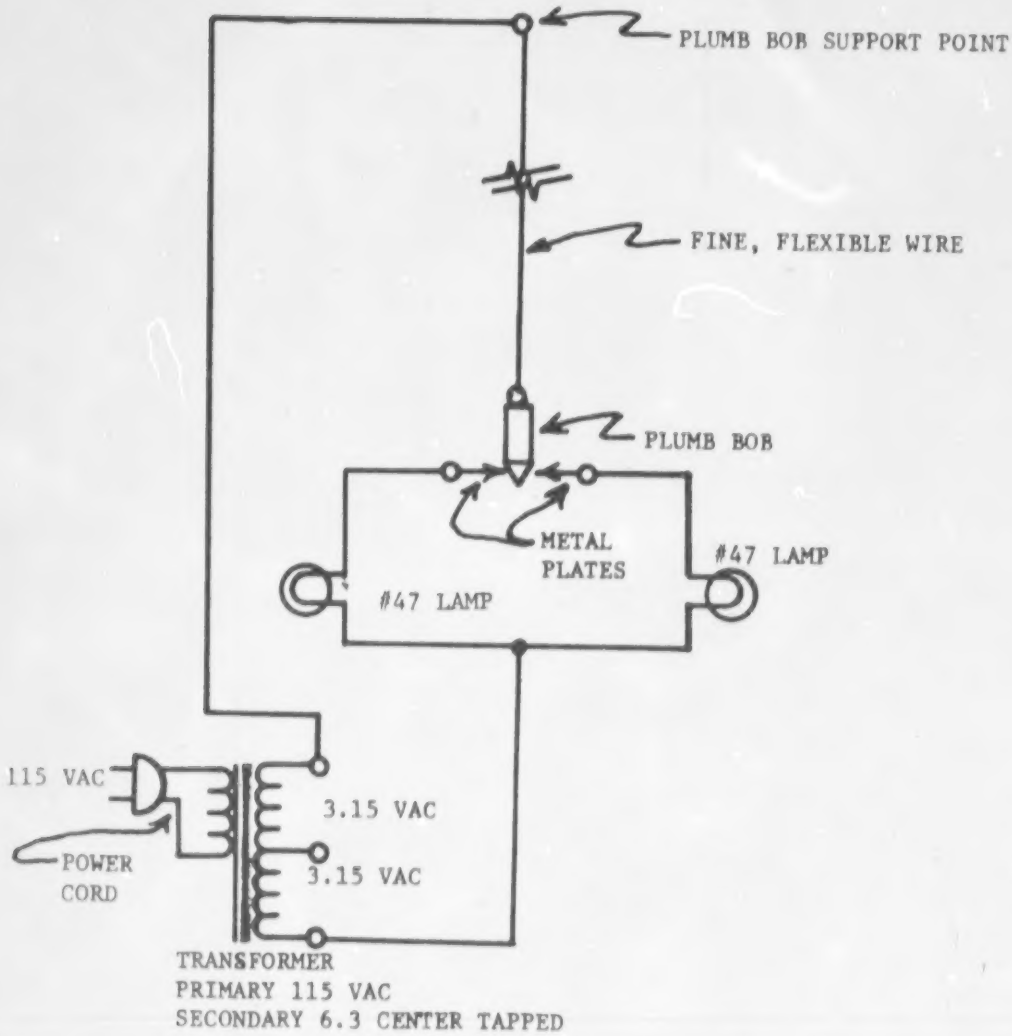
NOTES: 1. Pull-in current of relay is current registered by milliameter when relay closes (lamp turns on), as adjusted by control.

2. Drop-out current of relay is current registered by milliammeter when relay opens (lamp turns off), as adjusted by control

INSTRUCTOR AID

ENERGY SENSING AND CONTROL

USING PLUMB BOB WITH INDICATOR
LIGHTS TO INDICATE "LEVEL" CONDITION



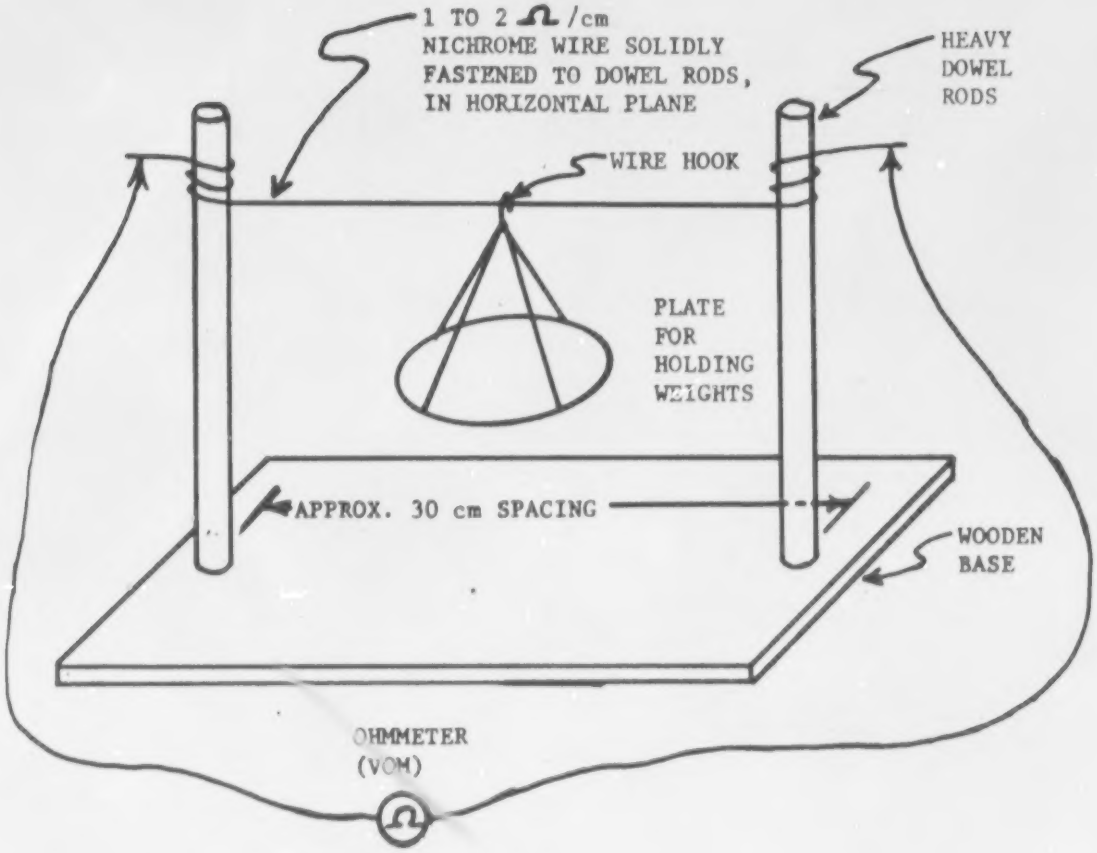
NOTES:
1. Transformer MUST be covered and all connection points properly terminated for safety during use.

2. The longer the plumb bob supporting wire and the closer the spacing of the metal contact plates, the more sensitive the system.

INSTRUCTOR AID

ENERGY SENSING AND CONTROL

MECHANICAL FORCE SENSING WITH NICHROME WIRE RESISTANCE CHANGE AS OUTPUT INDICATION (CRUDE STRAIN GAUGE)

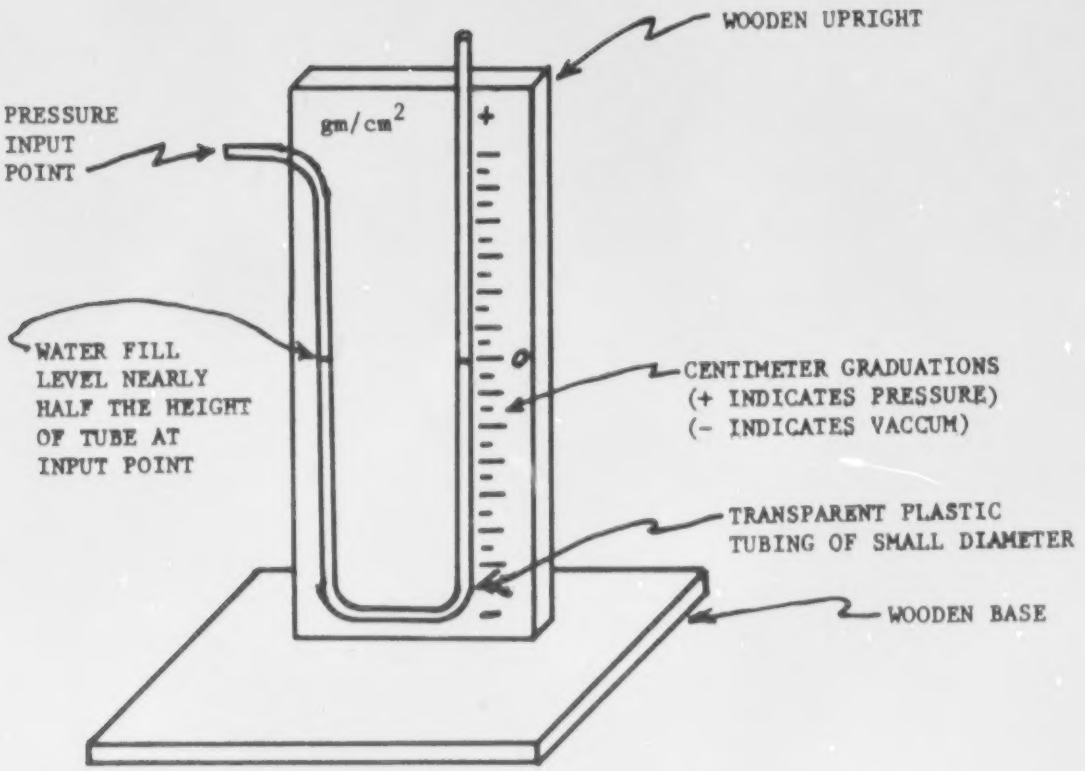


NOTES:
1. Measure and record resistance of wire with no weights on plate.
2. Add weights (50 to 100 g each) to plate and measure and record resistance of wire at each increment of total weight.
3. Plot a smooth graph of resistance (OHMS) versus total weight (grams) and inspect graph for linearity and for average ratio of resistance change to weight change.

INSTRUCTOR AID

ENERGY SENSING AND CONTROL

MECHANICAL FORCE (AIR PRESSURE)
SENSING WITH WATER MANOMETER



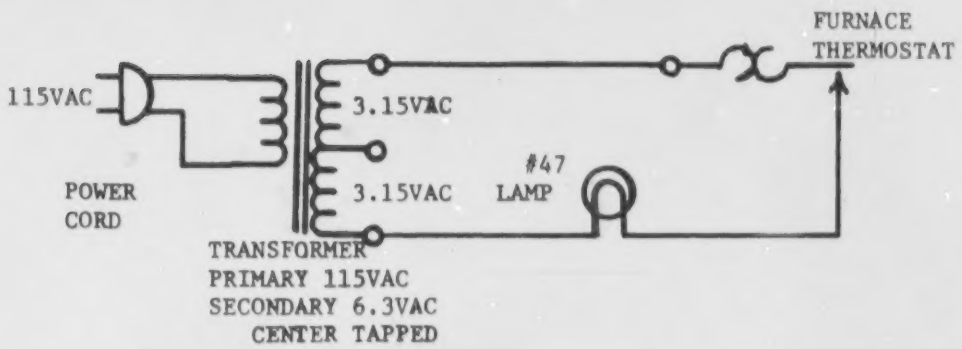
NOTES:
1. Pressure to be measured determines necessary height of manometer. Each cm graduation indicates one gram per square centimeter pressure. The English to metric system conversion factor is 1 pound per square inch equals 70.3067 grams per square centimeter.

2. One illustrative application is to use the manometer to measure the vaccum produced in the Venturi of a carburator, either an actual or a simulated one.

INSTRUCTOR AID

ENERGY SENSING AND CONTROL

TEMPERATURE SENSING WITH
HOME FURNACE THERMOSTAT
USING PILOT LAMP AS OUTPUT INDICATOR



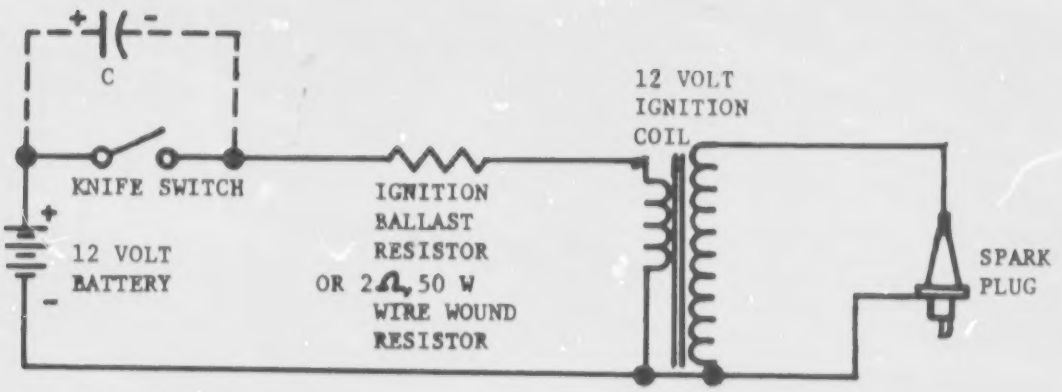
NOTES: 1. Transformer MUST be covered and all connection points properly terminated for safety during use.

2. Using a regular, accurate thermometer, the dial values on the furnace may be checked for accuracy by placing both side-by-side in various temperature surroundings.

INSTRUCTORS AID

ENERGY STORAGE SYSTEM

MAGNETIC FIELD ENERGY STORAGE



NOTES:

1. Closing of switch simulates closing of ignition points. Do not leave switch closed for extended duration of time. Current flow causes magnetic field energy storage in coil core.

2. Opening of switch simulates opening of ignition points. Stored magnetic field energy is dissipated as spark.

3. Optional capacitor C (regular ignition capacitor) will reduce arcing at switch when it is opened.

UNIT VI

6.00 ENERGY/POWER UTILIZATION 5 Days

OBJECTIVES: At the end of this unit, the student will be able to;

1. List and describe examples of energy consumption in each the residential, the commercial, the industrial, and the transportation categories of our society.
2. Identify and list factors which determine efficiency in energy/power appartuses.

UNIT OUTLINE

6.10 Residential

6.11 Light energy

6.111 Illumination

6.112 Sensing (alarms, etc.)

6.113 Viewing (TV)

6.114 Ultraviolet lamps

6.12 Thermal energy

6.121 Heating and cooling

6.122 Liquid and food refridgeration and heating

6.123 Heat lamps

6.13 Mechanical energy

6.131 Motor driven appliances and tools

6.132 Engine driven devices

6.133 Door activation mechanisms

6.14 Nuclear energy

6.141 Gaseous detection

6.20 Commercial (services and products are distributed)

6.21 Light energy

6.211 Illumination

6.212 Sensing (alarms, etc.)

6.213 Image development and viewing (film development and TV)

6.22 Thermal energy

6.221 Heating and cooling

6.222 Substance heating (ovens, torches, etc.)

6.223 Drying

6.23 Mechanical energy

6.231 Pneumatic driven (motor, piston and turbine devices)

6.232 Hydraulic driven (motor, piston and turbine devices)

6.233 Electric driven (solenoids)

6.24 Nuclear energy

6.241 Medical and food treatment

6.242 Gaseous detection

6.30 Industrial (products are produced)

6.31 Light energy

6.311 Illumination

6.312 Sensing

6.32 Thermal energy

6.321 Climate control

6.322 Substance heating

6.33 Mechanical energy

6.331 Pneumatic driven

6.332 Hydraulic driven

6.333 Electric driven

6.34 Nuclear energy

6.341 Inspection

6.342 Electrical production

6.40 Transportation

6.41 Air or space

6.411 Internal combustion (piston, rocket, turbine)

6.42 Surface

6.421 Internal combustion engines

6.422 External combustion engines

6.423 Electrical

6.424 Gravitational

6.425 Muscle

6.43 Water

6.431 Internal combustion engines

6.432 Nuclear

6.433 Muscle

6.434 Electrical

6.435 Wind rotor

TEXT: Bohn, Ralph C. and MacDonald, Angus J., POWER: MECHANICS OF ENERGY CONTROL, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1970. Chapter 10.

REFERENCES: Duffy, Joseph W., POWER: PRIME MOVER OF TECHNOLOGY, 2nd. Edition, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1972. Chapter 19.

UNIT NO. VI	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
6.00	ENERGY/POWER UTILIZATION THE STUDENT WILL BE ABLE TO:	
6.10--6.40	A. Determine the quantity of electricity, heating fuel, and other energies used in his/her residence.	A1. Read home electric power meter at exact time daily, or every several days, over a period of one or more weeks and correlate with family activity and/or cloudiness. A2. Read natural gas meter at exact time daily, or every several days, and correlate consumption with family activities and/or outdoor weather conditions.
	B. Determine and record the power ratings of individual illumination, appliance, and other devices in his/her residence.	B1. Select two or more desirable home appliances and/or power tools and develop criteria list regarding technical specifications. B2. List residential appliances, tools, machines, etc. found in the home and categorize each as to input and output form of energy. B3. List devices, tools, etc. of the home which use muscle power for operation.

UNIT NO. VI	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
	C. Investigate the affective efforts toward local, state, national, and international government ecological standards on the use of energy/power systems.	C1. Collect information regarding local and/or state environmental laws and/or rulings, i.e., open refuse disposal, noise pollution, waste-water treatment, etc.
	D. Identify power system characteristics conducive to minimization of servicing and maintenance.	D1. Read and discuss relationship of efficiency, reliablility, access for servicing, normal maintenance, etc. of several systems or devices such as automobile, television set, telephone, etc. (Consult Consumer Reports annual publication.)
	E. Identify current and future forms of energy, and the harnessing systems needed, which may be most applicable to the various utilization catsgories.	E1. Read, listen to reports, and/or view films on future alternative energy sources and discuss and/or report on same regarding the various utilization catagories.

UNIT VII

7.00 ENERGY/POWER CAREER OPPORTUNITIES 7 Days

OBJECTIVES: At the end of this unit, the student will be able to:

1. List ten areas of employment opportunity in the energy/power field.
2. List five jobs in the energy/power field and their accompaning duties and responsibilities and the education or training needed for job entry.

UNIT OUTLINE

7.10 Professional

- 7.11 Engineer/designer
- 7.12 Inventor
- 7.13 Researchers/scientists
- 7.14 Educators
- 7.15 Executives/managers

7.20 Technical

- 7.21 Quality/production supervisor
- 7.22 Engineering assistant
- 7.23 Superintendent/foreman
- 7.24 Drafting/design personnel
- 7.25 Experimental personnel

7.30 Skilled

- 7.31 Electricians

7.32 Assemblers

7.33 Machinists

7.40 Semi-skilled

7.41 On-the-job trainees

7.42 Self-improved workers

7.50 Unskilled

7.51 Helpers

7.52 Laborers

7.53 Attendants

TEXT: Bohn, Ralph C. and MacDonald, Angus J., POWER: MECHANICS OF ENERGY CONTROL, McKnight and McKnight Publishing, Co., Bloomington, Illinois, 1970. Chapter 11.

REFERENCES: Walker, John R., EXPLORING POWER TECHNOLOGY: BASIC FUNDAMENTALS, The Goodheart-Willcox Co., Inc., South Holland, Illinois, 1976. Chapter 1.

UNIT NO. VII	SELECTED STUDENT COMPETENCIES	SAMPLE LEARNING ACTIVITIES
7.00	ENERGY/POWER CAREER OPPORTUNITIES THE STUDENT WILL BE ABLE TO:	
7.10--7.50	A. Identify an organizational structure of man and machines of an energy industry and the duties and responsibilities of personnel within such an industry.	A1. Form a flow chart of a power related industry. A2. Visit an industry, observe, interview, compile, and summarize specific duties and responsibilities of different personnel in the industry.
	B. Identify preparatory education and skills (vocational/technical or professional) needed for a selected occupation in energy/power and programs from which such preparation can be obtained.	B1. Interview an energy/power worker and summarize job entrance requirements from this interview. B2. Use the Dictionary of Occupational Titles to find and record career information. (See librarian.)
	C. Identify safety considerations and attitudes regarding work in one or more of the energy/power occupations.	C1. Participate in safety survey.
	D. Identify the management of personnel in an organization and distinguish between employee job enrichment and job enlargement.	D1. Interview an industrial worker regarding boredom in doing a routine task in industry.

RESOURCES

APPENDIX A

ENERGY/POWER TECHNOLOGY

BIBLIOGRAPHY

Anderson, D. A., Electromechanisms: Motor Controls, Delmar Publishers, Albany, New York, 1971

Asimov, Isaac, Worlds Within Worlds: Atomic Weights, Energy, Electricity, U. S. Government Printing Office, Washington, D. C., Vol. 1, 1975.

Asimov, Isaac, Worlds Within Worlds: Mass and Energy, The Neutron, The Structure of the Nucleus, U. S. Government Printing Office, Washington, D. C., Vol. 2, 1975.

Asimov, Isaac, Worlds Within Worlds: Nuclear Fission, Nuclear Fusion, Beyond Fusion, U. S. Government Printing Office, Washington, D. C., 1975.

*Bohn, Ralph C. and MacDonald, Angus J., Power: Mechanics of Energy Control, McKnight and McKnight Publishing Company, Bloomington, Illinois, 1970.

Cook, Earl, "Energy Sources of the Future", The Futurist, World Future Society: An Association for the Study of Alternative Futures, Washington, D. C., August 1972, pages 142--152, Vol. VI, No. 4.

Dukert, Joseph M., Atoms on the Move: Transporting Nuclear Material, U. S. Government Printing Office, Washington, D. C., 1975.

Dukert, Joseph M., High-Level Radioactive Waste: Safe Storage and Ultimate Disposal, U. S. Government Printing Office, Washington, D. C., 1975.

**Duffy, Joseph W., Power: Prime Mover of Technology, McKnight and McKnight Publishing Co., Bloomington, Illinois, 1972.

Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Controlling Electrical Energy, Unit 1, Bruce Publishing Co., Beverly Hills, California, 1973.

Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Controlling Electrical Energy, Unit 2, Bruce Publishing Co., Beverly Hills, California, 1973.

Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Control Devices and Systems, Unit 3, Bruce Publishing Co., Beverly Hills, California, 1973.

Dugger, William; Patrick, Dale; Suess, Alan: and Ziegler, James; Communications, Unit 4, Bruce Publishing Co., Beverly Hills, California, 1973.

Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Computer Concepts, Unit 5, Bruce Publishing Co., Beverly Hills, California, 1973.

Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Measurement and Control, Unit 6, Bruce Publishing Co., Beverly Hills, California, 1973.

Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Measurements, Unit 7, Bruce Publishing Co., Beverly Hills, California, 1973.

**Dugger, William; Patrick, Dale; Suess, Alan; and Ziegler, James; Introduction to Power Systems, Bruce Publishing Co., Beverly Hills, California, 1976.

Hogerton, John F., Nuclear Reactors, U. S. Government Printing Office, Washington, D. C., 1974.

Jenson, Cecil H., Engineering Drawing and Design, McGraw Hill Co.,, 1968.

Lyerly, Ray L. and Mitchell III, Walter, Nuclear Power Plants, U. S. Government Printing Office, Washington, D. C., 1973.

Mix, Floyd M., House Wiring Simplified, Goodheart-Willcox Co., Inc., South Holland, Illinois.

NASA, Space Resources for the High School Industrial Arts Resource Units.

**Portola Institute, Energy Primer: Solar, Water, Wind and Biofuels, Fricke-Parks Press Inc., Fremont, California, 1974.

**Power, Editors of, Power-Generation Systems, McGraw Hill Co., 1967.

Robertson, L. P., Tinnell, R. W., Watts, T. G., and Yeager, D. A., Mechanisms: Linkages, Delmar Publishers, Albany, New York, 1972.

Robertson, L. Paul, Hunter, Bob R., and Allan Richard L., Electro-mechanisms: Devices, Delmar Publishers, Albany, New York, 1971.

**Sargent-Welch Scientific Co., The Metric System and SI Measurements and System of Units, Sargent-Welch Scientific Co., Skokie, Illinois, 1974.

Sears, Roebuck and Co., Simplified Electrical Wiring, Sears, Roebuck and Co., Minneapolis, Minnesota, 1969.

**Stephenson, George E., Power Technology, Delmar Publishers, Albany, New York, 1973.

**Turner, Rufus P., Solar Cells and Photocells, Howard W. Sams and Co., Inc., 1975.

Tinnell, Richard W., Mechanisms: Drives, Delmar Publishing, Albany, New York, 1971.

United States Research and Development Administration, Advanced Nuclear Reactors, U. S. Government Printing Office, Washington, D. C., 1975.

**Walker, John R., Exploring Power Technology, Goodheart-Willcox Co., Inc., South Holland, Illinois, 1976.

Yellott, John I., Solar Energy Utilization for Heating and Cooling, U. S. Government Printing Office, Washington, D. C. 1974.

**Essential as instructor's reference
*Suggested classroom text

APPENDIX B

ENERGY/POWER TECHNOLOGY

VISUAL AIDS SOURCES

American Petroleum Institute
1271 Avenue of the Americas
New York, New York 10020

Americans for Energy Independence
1500 Wilson Blvd., Suite 1405
Arlington, Virginia 22209

Johns-Manville Magazine
Greenwood Plaza
Denver, Colorado 80217

NASA Technology Utilization Office
P. O. Box 8756
Washington International Airport
Baltimore, Maryland 21240

National Areonautics and Space Administration
Washington, D. C. 20546

North Dakota Petroleum Council
Bismarck, North Dakota 58502

Publications Distribution
American Institute of Architects
1735 New York Avenue, N. W.
Washington, D. C. 20006

U. S. Department of Commerce
(NOAA) National Oceanic and Atmospheric Administration
Washington, D. C.

U. S. Department of Housing and Urban Development
Washington, D. C. 20410

U. S. Department of Interior
Bureau of Reclamation
Washington, D. C.

U. S. Energy Resources Development Administration
Technical Information Center Film Library
P. O. Box 62
Oak Ridge, Tennessee 37830

Technical Films
NASA Manned Spacecraft Center
Public Affairs Office (Ap.-2)
Houston, Texas 77058

APPENDIX C

ENERGY/POWER TECHNOLOGY

STUDENT ACTIVITY REPORT FORM (sample)

NAME:_____ DATE:_____

TITLE OF ACTIVITY:_____

OBJECTIVE(S) OF ACTIVITY:

MEASURED, OBSERVED, AND/OR EXPERIMENTAL DATA:

CONCLUSIONS (WHAT WAS LEARNED FROM THIS ACTIVITY):

SUGGESTIONS, COMMENTS, AND/OR CONSTRUCTIVE CRITICISMS: